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NATIONAL DAM SAFETY PROGRAM. LAKE LORRAINE DAM (MO 30433) JEFFE--ETC(U)
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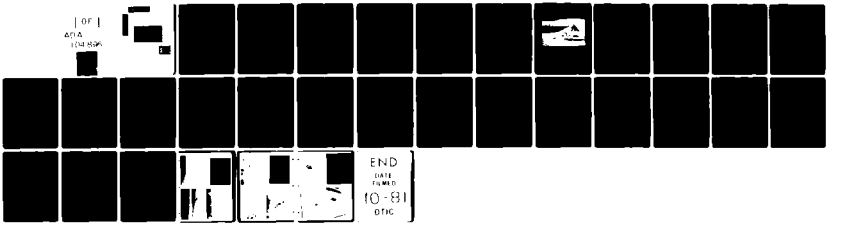

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4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Lake Lorraine Dam (MO 30433) Jefferson County, Missouri	5. TYPE OF REPORT & PERIOD COVERED Final Report / 6. PERFORMING ORG. REPORT NUMBER
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16. DISTRIBUTION STATEMENT (of this Report)

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National Dam Safety Program. Lake Lorraine Dam (MO 30433) Jefferson County, Missouri. Phase I Inspection Report.

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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☆ U.S. G.P.O. 1980-665-141/1299

MISSISSIPPI RIVER BASIN

Lake Lorraine Dam
Jefferson County, Missouri

Inventory No. 30433

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared: St. Louis District, Corps of Engineers

For: Governor of Missouri

April 1978

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name:	Lake Lorraine Dam
Location:	Jefferson County, Missouri
Stream:	Unnamed Tributary to Sandy Creek
Date of Inspection:	4 January 1978

Summary: Lake Lorraine Dam was inspected using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington D.C., with the help of Federal and State Agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering fraternity.

Using the guidelines, the dam is in the significant hazard potential classification, which means that loss of a few lives and appreciable property loss could occur in the event of failure or misoperation of the dam or appurtenant structures. The dam is in the Intermediate size classification because its height exceeds 40 feet.

Conclusions: The inspection team visually observed animal burrows and a thick cover of brush and small trees on the downstream slope. The upstream slope has a lesser but appreciable brush cover. Our evaluation of the spillway size indicates that it does not meet the criteria in the guidelines. Assuming the pool level at the invert (bottom) of the outlet pipe, the spillway is adequate to pass peak flow resulting from a storm having frequency of occurrence from once in five to once in ten years. Reservoir leakage provides additional storage and outlet capacity, reducing the potential of overtopping an unknown degree. The guidelines recommend a dam of this size and hazard classification have a spillway capable of passing half to all of the probable maximum flood (PMF). The PMF is not assigned a statistical frequency, but is more rare than a 100-year frequency flood. Spillway construction does not appear sufficiently erosion-resistant to prevent possible embankment erosion at high flows. A downstream leak, or spring, approximately 1000 feet from the dam was pointed out by the management and a resident. The observed spring is not considered to endanger the safety of the dam. We do not recommend a Phase II inspection (additional investigation) since

design and construction of remedial works could begin with existing data. We recommend that the deficiencies listed herein be corrected by the owner in the near future. These conclusions were reached by the undersigned inspection team members.

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THOMAS F. WOLFF
Soils Engineer

Michael Cullen
MICHAEL CULLEN
Hydraulic Engineer

for Nels S. Johnson
MICHAEL J. KLOSTERMAN
Geologist

SUBMITTED BY: John R. Hiemi
Chief, Engineering Division

7 April 78
Date

APPROVED: Leon E. Mc Kee
Colonel, CE, District Engineer

10 April 1978
Date

OVERVIEW PHOTO

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE LORRAINE DAM

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LIST OF PLATES

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE LORRAINE DAM ID NO. 30433

SECTION I -- PROJECT INFORMATION

1.1 GENERAL.

a. Authority: The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the Lake Lorraine Dam be made.

b. Purpose of Inspection: This inspection was conducted to determine if this dam constitutes a hazard to human life or property.

c. Criteria: The inspection was accomplished using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington D.C., with the help of Federal and State Agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering fraternity.

1.2 DESCRIPTION OF PROJECT.

a. Description of Dam and Appurtenances: Lake Lorraine dam is an earth-fill dam with a notch spillway in the right abutment. The spillway is cut into a combination of earth and rock, and is paved with unreinforced concrete (See Photos 1 through 5).

b. Location: The dam is located on an unnamed tributary of Sandy Creek near the northeast corner of U. S. Survey 1976, T41N, R4E. The lake extends into Section 1 (See Plates 1 and 2).

c. Size Classification: Criteria for determining the size classification of dams and impoundments are presented in Volume 1, Appendix D, Chapter 2, of the National Program of Inspection of Dams Report. Based on these criteria, this dam and impoundment is in the intermediate category.

d. Hazard Classification: Criteria for determining hazard classification are presented in the same report as referenced in paragraph c above. Based on referenced criteria, this dam is in the Significant Hazard Classification.

e. Ownership: Frimel Realty Co.

f. Purpose of Dam: Recreation for adjacent housing development.

g. Design and Construction History: Reportedly begun in 1955 by previous developer. Sold to Frimel Realty, who completed dam in 1957. No other information available.

h. Normal Operational Procedure: Water flows through a 30-inch culvert under uncontrolled spillway. Plywood/steel gate on culvert may be used to provide some additional water storage.

1.3 PERTINENT DATA.

a. Drainage Areas: 834 acres.

b. Discharge at Damsite:

(1) Maximum known flood at damsite: Not known. Spillway flow is reported to have occurred.

(2) Ungated spillway capacity at maximum pool elevation: 1412 cfs.

(3) Total spillway capacity at maximum pool elevation: 1423 cfs.

c. Elevation: (ft. above msl) (Based on assumed bench mark from USGS topo map)

(1) Top of Dam: 543±.

(2) Flood control pool (spillway invert): 537.5±.

(3) Recreation pool (conduit invert): 535±.

(4) Streambed: 500±.

(5) Maximum tailwater: Not known.

d. Reservoir:

(1) Length of maximum pool: 1800 ft.

(2) Length of recreation pool: 1300 ft.

e. Storage: (acre-feet)

(1) Recreation pool: 400.

(2) Flood control pool: 400.

(3) Design surcharge: 176.

(4) Top of dam: 576.

f. Reservoir Storage: (acres)

(1) Top of dam: 38.0

(2) Maximum pool: 38.0

(3) Flood-control pool: 28.5

(4) Recreation pool: 28.5

(5) Spillway crest: 28.5

g. Dam:

(1) Type: Earth fill.

(2) Length: 1100± feet.

(3) Height: 45 feet.

(4) Top width: 14 feet.

(5) Side slopes: Variable, typically 1V on 2.2H upstream, 1V on 2.5H downstream. A profile and three sections are shown on Plate 3.

(6) Zoning: Unknown.

(7) Impervious core: Unknown. Sandy clays at embankment surface appear relatively impervious.

(8) Cutoff: Unknown. A lake resident indicated the earth embankment was reportedly keyed into a rock trench.

(9) Grout curtain: Five grout pipes in crown and one found at toe. Pipes are asphalt filled. Grouting was reportedly accomplished during the period 1962-65 in an effort to stop reservoir leakage. Original grouting unknown.

h. Diversion and Regulating Tunnel: None.

i. Spillway:

(1) Type: Earth/rock notch in right abutment faced with unreinforced concrete; 30-inch corrugated metal pipe under spillway.

(2) Effective length of weir: 55 feet.

(3) Crest elevation: 537.5 spillway; 535 culvert.

(4) Gates: Plywood/steel plate over culvert.

(5) Upstream channel: Earth.

(6) Downstream channel: Earth/rock.

j. Regulating Outlets: 30-inch corrugated metal pipe; upstream invert 535.1 ft. msl, 32 ft. long with a downstream invert at 534.8 ft. msl. This pipe is blocked on the upstream side with a piece of plywood and also a metal plate. The metal plate could not easily be removed in time of emergency (See Photo 5).

SECTION 2 -- ENGINEERING DATA

2.1 DESIGN.

No known data available, per lake manager.

2.2 CONSTRUCTION.

Based on interview with lake manager and one resident, dam was reportedly constructed with borrow material from lake bottom and left abutment. Lake bottom material was excavated in deep trenches to top of rock.

2.3 OPERATION.

Uncontrolled except for use of plywood/steel plate on culvert which allows 2.5-foot additional pool before spillway flow.

2.4 EVALUATION.

a. Availability: None.

b. Adequacy: The visual inspection and 20-year performance were considered adequate to support the conclusions reached in this report.

c. Validity: Not applicable - no data.

SECTION 3 -- VISUAL INSPECTION

3.1 FINDINGS.

a. General: The lake manager and a resident accompanied the inspection team. A spring pointed out by these persons was observed exiting in a creek approximately 1000 feet downstream at approximate elevation 500. (See photo 9) The location of the spring is shown in Plate 2. The water exits from under an outcrop of white dolomite. The water is clear and the quantity of flow is estimated to be on the order of 10 gallons per minute. On the date of the inspection, the air temperature was 40 degrees, and the temperature of the spring water was 47 degrees. Ground water in Missouri is typically 55 to 57 degrees. The lake was ice-covered. The spring is not considered to endanger the safety of the dam because of its distance and clearness of the water. The site was revisited by the team leader and a geologist on 23 January 1978.

The relatively low lake level implies some reservoir leakage is occurring. The low lake level provides some additional protection in the form of storage should a large rainfall occur. The area immediately downstream of the dam and the abutments were examined closely and no seepage was observed.

b. Project Geology: Field investigation indicated the bedrock immediately downstream of the damsite consists of fine to medium grained, thin and medium bedded, gray-brown dolomite, probably of the Joachim formation. The Joachim lies stratigraphically above the quartzose sandstone of the St. Peter formation. Outcrops above the dam were of fine grained, medium bedded, gray limestone, probably of the Plattin formation. Other than the small seep below the dam, no evidence of karst or solution activity was discovered.

c. Dam: No detrimental settlement, depressions, cracking, or sinkholes were observed in or near the embankment.

Typical embankment slopes are indicated in Section 1.3. The downstream slope in particular was irregular. An apparently old slide was noted in the downstream slope at approximately Sta. 8+50. The slide scarp is covered with vegetation and shows no evidence of recent movement.

Animal burrows are evident at many locations on the downstream slope, including locations lower than pool level. (See photo 7) These burrows constitute a potential seepage hazard.

The downstream slope is covered entirely with brush and trees. (See photo 3) The larger trees are on the order of 8 inches in diameter. These root systems constitute a potential seepage hazard. The vegetation also provides animal habitat which increases the likelihood of animal burrows. Machete-clearing was necessary to obtain survey cross-sections.

Based upon surface observations, the embankment is comprised of reddish brown, sandy to very sandy clay. No seepage was observed at any location in the immediate vicinity of the embankment. Gully erosion was observed at or near the downstream embankment interface on both ends of the dam. On the right abutment, the gully was about 3 feet deep. (See photo 8) Five grout pipes were found in the crown and one at the toe as described in Section 1. Additional pipes may be located downstream but were not apparent due to the heavy brush cover. No embankment drainage system is apparently provided.

The upstream slope is partially protected by riprap. The riprap consists of slabby dolomite pieces ranging from 3 to 9 inches in size placed along the upper 6 feet of the slope. The riprap is not well graded and does not provide a complete cover. The remainder of the upstream slope is covered with grass and brush. No benching or significant erosion was noted on the upstream slope. Significant wave heights would not be expected because of the lake's small size and protection by high topographic ridges.

d. Appurtenant Structures: The spillway consists of an earth/rock notch in the right abutment approximately 55 feet wide and 5 feet deep. (See photos 4 & 5) The spillway and a short length of the downstream channel are covered by approximately 2 inches of unreinforced, unformed concrete paving. The paving is cracking and does not appear sufficiently erosion-resistant to prevent erosion of the adjacent embankment in the event of large spillway flows.

A 30-inch-diameter corrugated metal pipe (CMP) is located just below the spillway invert. The pipe has been blocked by a plywood/-steel plate in an effort to retain water at high lake levels.

e. Reservoir Area: No pertinent problems were noted.

f. Downstream Channel: An earth channel to pass culvert flows is provided. No well-defined spillway exit channel exists. See Section 5 for more detailed discussion.

3.2 EVALUATION.

Trees, bushes, and rodent holes on the dam and insufficient erosion protection for the spillway are all serious deficiencies which should be corrected.

SECTION 4 -- OPERATIONAL PROCEDURES

4.1 PROCEDURES.

Operational procedures are essentially nonexistent, since the dam has an uncontrolled spillway. As previously stated, a makeshift gate on the 30-inch pipe can be used to regulate lake levels to some extent. No formal operational procedure is known to exist.

4.2 MAINTENANCE OF DAM.

Little maintenance is apparent as evidenced by the heavy vegetative cover. The spillway concrete pavement was reportedly repaired in the past year.

4.3 MAINTENANCE OF OPERATING FACILITIES.

Not applicable.

4.4 WARNING SYSTEM.

The existence of a warning system is unknown.

4.5 EVALUATION.

Additional maintenance in the form of clearing and mowing the embankment and filling animal burrows is recommended.

SECTION 5 -- HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES.

a. Design Data: No design data were made available to the Inspection Team. No formalized plan of lake regulation apparently exists.

b. Experience Data: The drainage area, lake surface area and storage, and spillway rating data were developed from U. S. Geological Survey 7-1/2 min. quadrangle sheets and surveys made during the lake inspection.

c. Visual Observations: The following deficiencies were noted:

The concrete protection on the upstream face of the spillway section is cracked, spalling, and near the pipe culvert, missing.

Tree cuttings were placed in the spillway approach area.

The upstream face of the dam has spotty rock protection and is not uniform or continuous; however, no benching or erosion was noted above the lake level indicating the lake does not remain at higher stages for significant periods of time and wave action caused by wind action causes no problem.

The lake evidently remains at or below the elevation observed during the inspection as vegetation appears on the dam and in the spillway above this elevation. This level is about 10.5 feet below the spillway crest and 8 feet below the 30-inch CMP invert.

No well-defined spillway exit channel exists other than the channel for pipe flow.

The natural stream channel below the dam at the intersection of the pipe's channel is not well defined. The area is covered with vegetation, trees, and some trash. This indicates the CMP and/or spillway seldom pass water. This location is well downstream from the toe of the dam and spillway flow would not adversely affect the integrity of the dam. A seep was observed in the rock formation that forms the bottom of the exit channel at about elevation 504 ft. msl. (See photo 6)

An excavated area exists immediately upstream of the spillway section, the depth of which extends below the concrete protection.

Recent rainfall in the area was sufficient to cause spillway flow at a nearby lake while this lake's water level is some 10 feet

below the spillway crest. This indicates the lake is losing water. Water was observed flowing from a rock outcrop about 1000 feet downstream of the dam.

The valley below the dam is mostly cultivated fields extending about 3300 feet downstream to Lemay Ferry Road.

d. Overtopping Potential: The capacity of the spillway to pass inflow is very limited. If the pool level were at the spillway invert, the peak inflow of a flood having a frequency of recurrence between once in five and once in ten years would exceed the spillway capacity. Assuming no water losses and the lake filled to the spillway invert at the time the storm began, the dam would be overtopped by a flood event which has a frequency of occurrence of once in less than 100 years. However, because the spillway is not sufficiently erosion resistant as discussed in Section 3.1d, one or more periods of sufficiently large spillway flow could jeopardize the dam. The fact that the lake loses water, thus providing additional storage and unknown additional discharge capability, reduces the potential of overtopping an unknown degree.

Failure of two small lakes located in the watershed would not significantly raise the Lake Lorraine or increase the overtopping hazard.

Overtopping the dam could result in a failure which could destroy at least one home located approximately 3400 feet downstream of the dam with possible loss of life. No warning system could be effectively implemented because of the proximity to the dam and the speed of the water traveling over the open fields between the dam and the residence. Low-lying structures in the town of Goldman, three-fourth miles downstream from the dam, could experience significant flood damage.

SECTION 6 -- STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY.

a. Visual Observations: Visual observations of the dam and spillway are discussed and evaluated in Section 3. The dam has no other appurtenant structures.

b. Design and Construction Data: Except as discussed in Section 2, no significant design or construction data are available.

c. Operating Records: No operating records were available.

d. Post-Construction Changes: As discussed in Section 1.3, asphalt grouting was performed, reportedly in the period 1962-65, to reduce reservoir leakage. As discussed in Section 3.1, a plywood/steel plate has been placed over the pipe below the spillway to retain additional water.

e. Seismic Stability: Lake Lorraine Dam is located in seismic zone 2, for which the recommended guidelines for inspection assign a "moderate" damage probability and design seismic (earthquake) coefficient of 0.05. Since neither original design analysis nor strengths of construction materials are available, an accurate seismic analysis cannot be made. The relatively low dam height and clayey materials in the dam are factors minimizing the likelihood of failure due to earthquake.

SECTION 7 -- ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT.

a. Safety: Several items are deficient which should be corrected. These items are vegetative cover, animal burrows, insufficient erosion protection for the spillway, and insufficient spillway capacity.

b. Adequacy of Information: Essentially no details are available regarding design of the dam. Data from the visual inspection are considered adequate to support the conclusions herein.

c. Urgency: We recommend the remedial actions recommended in Section 7.2 be accomplished in the near future.

d. Necessity for Phase II: No Phase II inspection is considered necessary. The recommended remedial actions can be accomplished without further investigation.

7.2 REMEDIAL MEASURES.

The following remedial measures are recommended:

a. Remove trees and bushes.

b. Fill animal burrows.

c. Establish and maintain a grass cover on the embankment.

d. Provide an adequately sized, erosion-resistant spillway. The spillway should be redesigned and constructed to pass, at least, the peak inflow at one-half the probable maximum flood. The observed excavation in the spillway approach channel should be refilled and protected.

e. No debris dumping should be allowed in the lake area.

f. If and when the water loss problem is corrected, adequately sized and properly placed riprap should be placed on the upstream face of the dam above elevation 534.0.

g. An exit channel of efficient, adequate size from the outfall of the CMP channel to the seep location in the existing exit channel should be constructed.

h. The residents near Goldman should be advised of the flooding potential from overtopping of Lake Lorraine Dam.

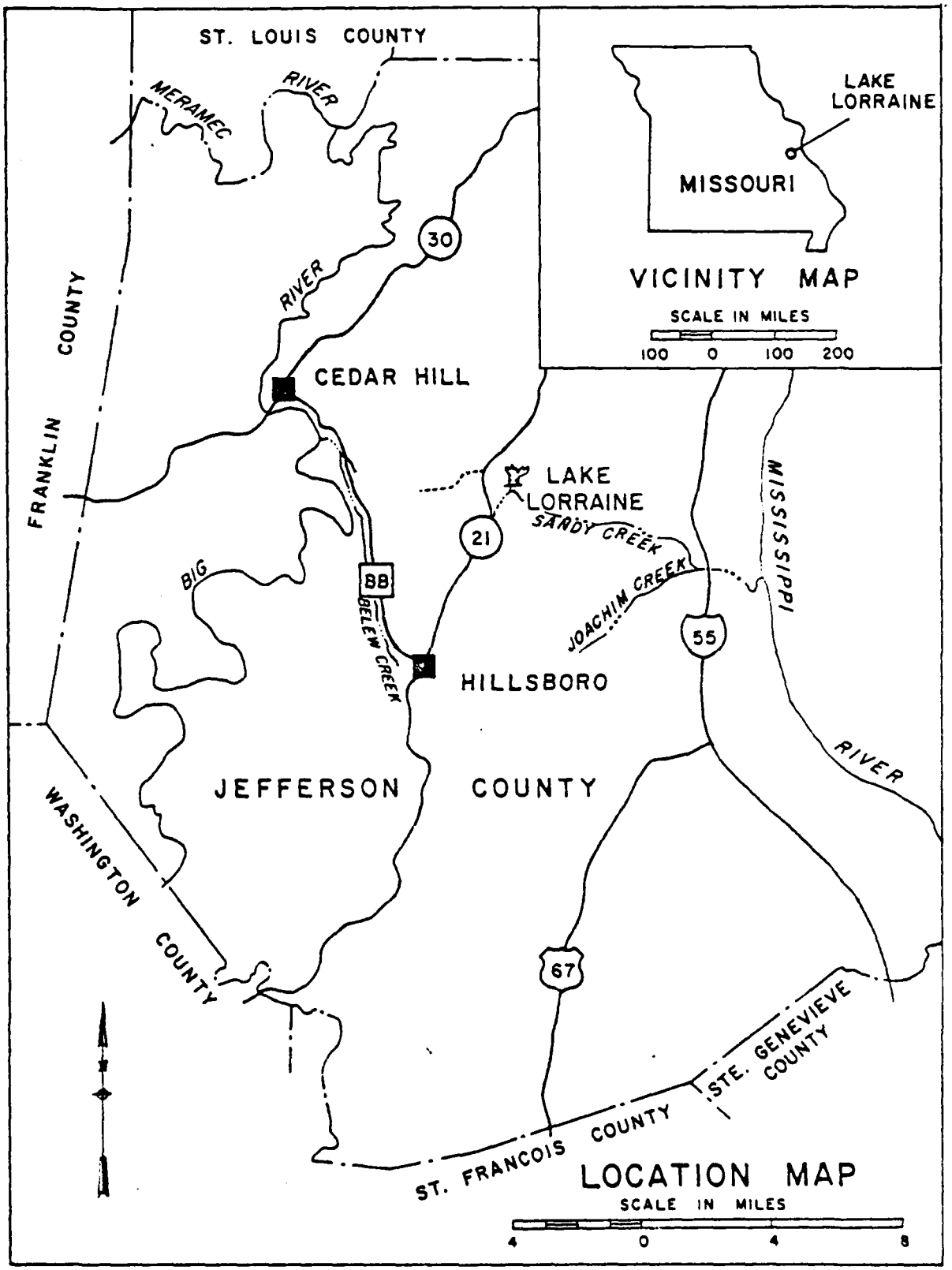
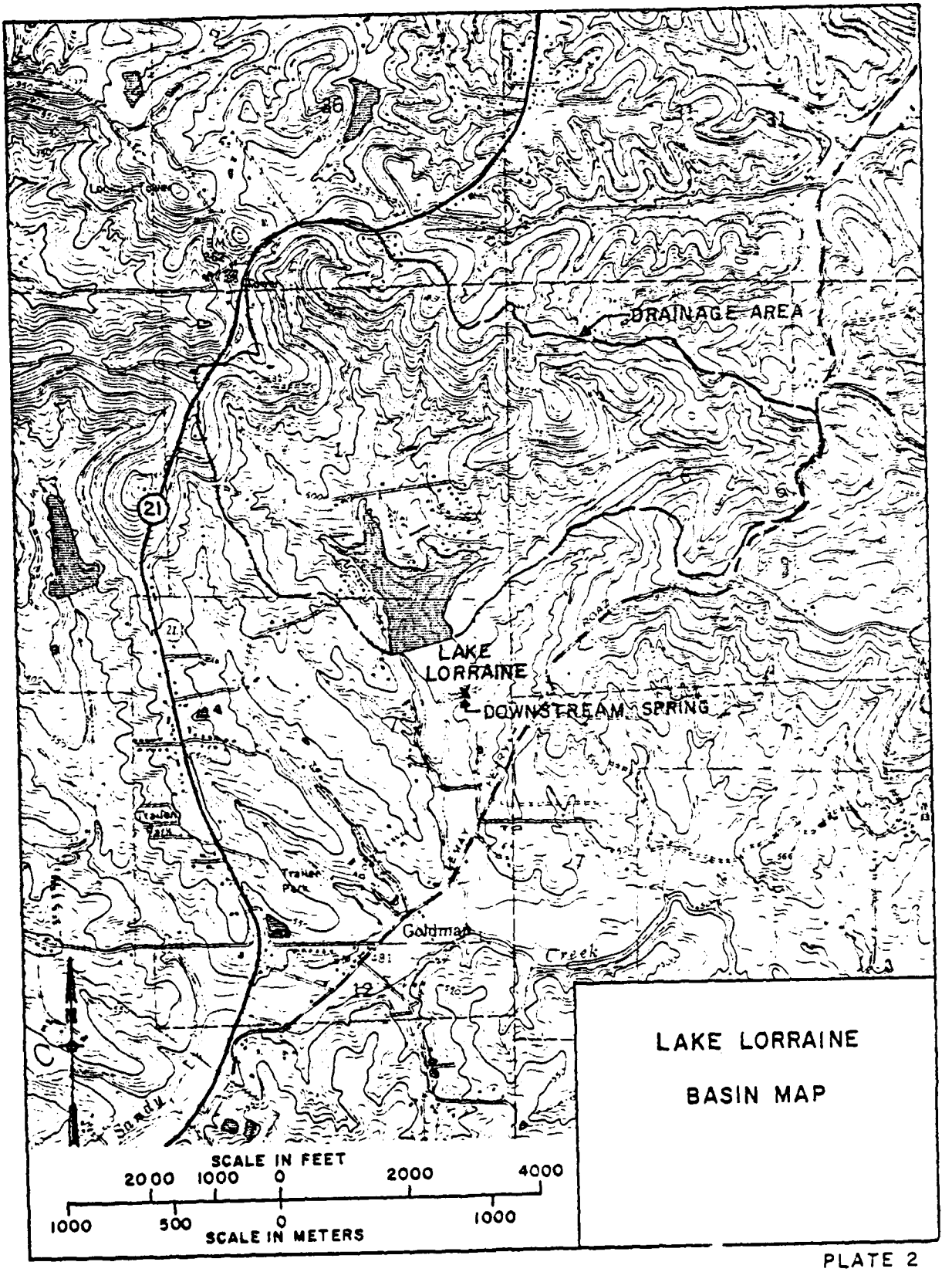

ST. LOUIS COUNTY
MERAMEC
RIVER
30
RIVER
FRANKLIN
COUNTY
CEDAR HILL
LAKE
LORRAINE
SANDY CREEK
21
BIG
88
BELEW CREEK
HILLSBORO
JOACHIM CREEK
55
MISSISSIPPI
RIVER
JEFFERSON
COUNTY
WASHINGTON
COUNTY
67
STE. GENEVIEVE
COUNTY
ST. FRANCOIS COUNTY
LOCATION MAP
SCALE IN MILES
4 0 4 8
LAKE
LORRAINE
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100 200

PLATE I



LAKE LORRAINE

BASIN MAP

PLATE 2

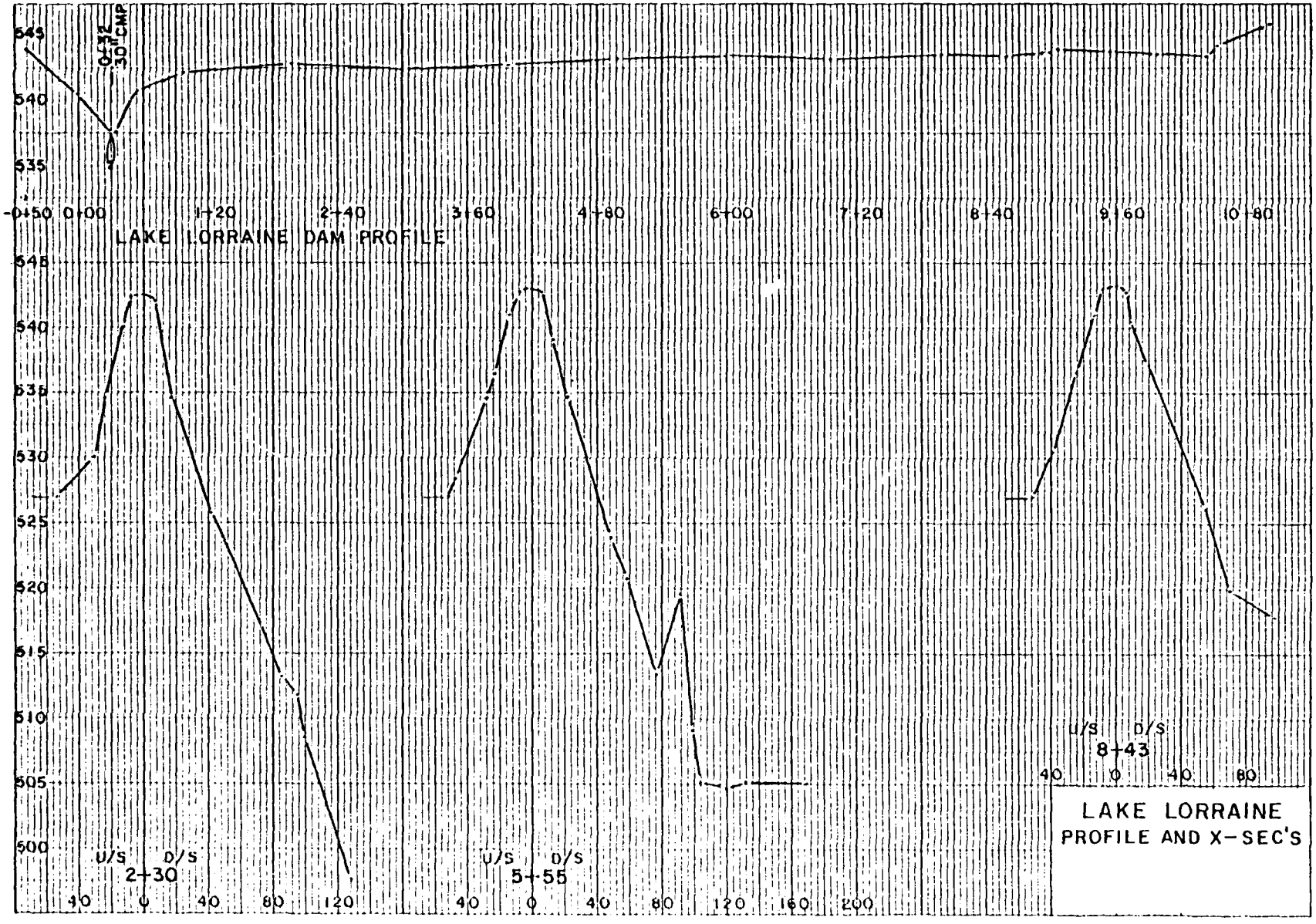

LAKE LORRAINE DAM PROFILE
0+32
30" CMP
545
540
535
-0+50
0+00
1+20
2+40
3+60
4+80
6+00
7+20
8+40
9+60
10+80
545
540
535
530
525
520
515
510
505
500
U/S
D/S
2+30
40
0
40
80
120
U/S
D/S
5+55
40
0
40
80
120
160
200
U/S
D/S
8+43
40
0
40
80
LAKE LORRAINE
PROFILE AND X-SEC'S

PLATE 3

HYDRAULIC COMPUTATIONS

PROJECT		COMPUTED BY	DATE
DAM SAFETY INSPECTION	Page 1 of 2	MJC	20 JAN '78
SUBJECT		**CHECKED BY**	**DATE**
LAKE LORRAINE			

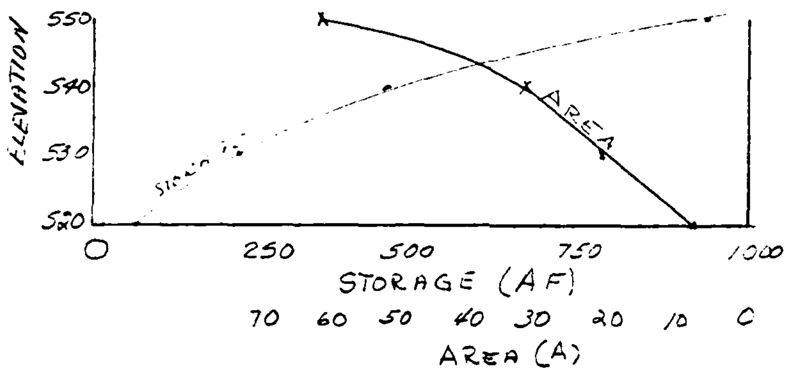
PERTINENT DATA:

1. LAKE IS LOCATED IN Secs 1&12 T41N, R4E. BELEW CREEK Q[illegible]

2 DRAINAGE AREA (from QUAD) 834 Acres

3.

El.(FTMSL)	AREA(A)	STORAGE(AF)
500	0	0
10	2.75	14
20	7.35	64
30	21.58	209
40	33.14	478
550	61.99	948



From TP 40 Page 27 Probable Max. Precip. = 27"
for 6 hour - 10 square Miles.

Spillway Rating Curve. $Q = C L H^{3/2}$ $C = 2.[illegible]$

Elev.	Q
537.5	0 cfs
38.5	36
39.5	17?
40.5	500
41.5	836
4?.5	1413 cfs

Pipe Culvert 3[illegible]
Assume 1' Drawdown [illegible]
ΔH = [illegible]

From co Handbook Q = [illegible]
[illegible]

From T.P. 40 30 min duration

Freq	Intensity	FREQ	INTENSITY
1 yr	1.1 inch	50 YR	2.4 inch
2	1.3	100 "	2.6
5	1.[illegible]		
10	1.?		
[illegible]	2.[illegible]		

PROJECT Dam Safety Inspection	Page 2 of 2	COMPUTED BY MJC	DATE 31 Jan 78
SUBJECT		CHECKED BY	DATE

RATIONAL METHOD - ARMCO HANDBOOK -

$Q = CIA$

ASSUMED
$C = 0.55$ $A = 834$
$L = 8750'$ $\Delta h = 375'$ $S_{500} = 0.0429$
$T_c = 29$ min.

Frequency	$I_{(t)}$	Q peak cfs
2	2.5	1146
5	3.2	1468
10	3.75	1720
25	4.4	2018
50	4.8	2201
100	5.2	2385

Extrap. using Fig 3-3

Probable Max. Flood peak = 9,000 cfs

½ PMF = 4,500 cfs

Spillway cannot pass more than 5 year storm

Unit Synthetic Hydrograph for Small Watersheds from H Gray ASCE ...

$P_R/\gamma = 20$ min $\gamma' = 2.676 + 0.0139\gamma$

$P_R/\gamma'_t = 1/2.676/P_R + 0.0139 = 8.29$

$P_R/\gamma' = 8.29$ $\gamma = 6.18$ $P_R = 25.07$ $\gamma' = 3.02$ $q = 4.02$

$Q_{P_{\%}} = \frac{25(\gamma')^q e^{-\gamma'}}{\Gamma(q)} = \frac{25 \times (3.02)^{4.02} e^{-3.02}}{\Gamma(4.02)}$

$= \frac{2136.02}{6.18} = 16.787$

$V = 1 \times 834 \times 43560/12 = 3,027,420$
$V_D = .25 \times 30 \times 60 = 300$

$Q_{peak} = \Sigma cfs = V/V_D = 9,970$ cfs $\times 16.78 = 1673$ cfs / inch runoff

$t/P_R = 1$ $t = 25.07$

Celerity - house downstream 3350 ft.
Assume Rectangular Section Failure.

$C = \sqrt{g D}$

Assume	C	Time to first house
D = 50	40.1 ft/sec	~1½ min.
- 25	28.7	~2
10	17.9	~3
5	12.7	~4½

PHOTOGRAPHS

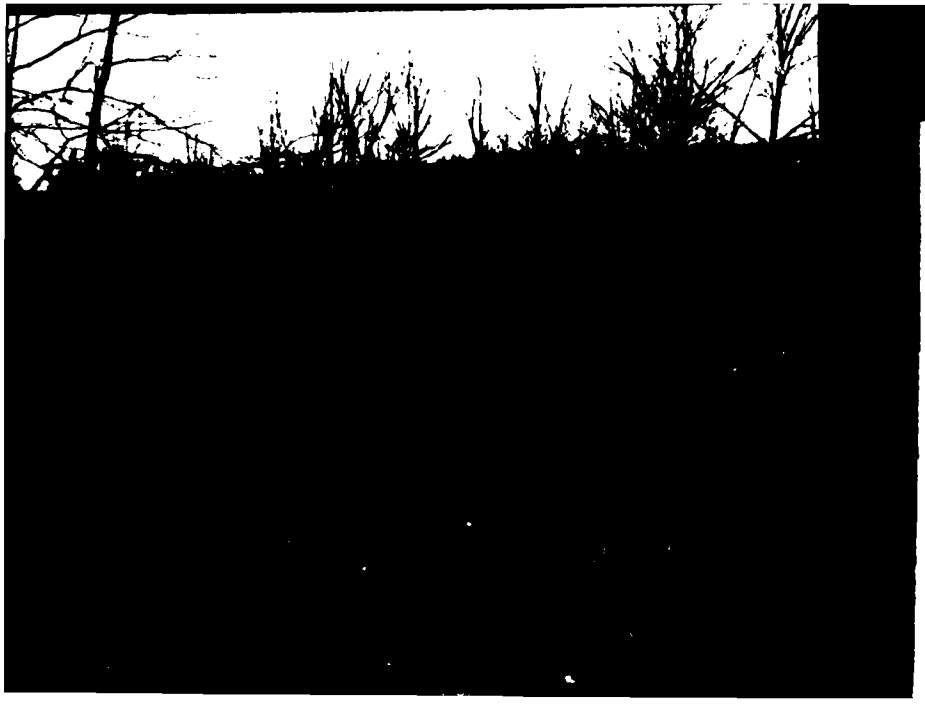


PHOTO 1: Upstream face of dam

PHOTO 2: Crown of dam

PHOTO 3: Downstream slope

PHOTO 4: Downstream side of spillway

PHOTO 5: Upstream side of spillway

PHOTO 6: End of exit channel